A Paris-Edinburgh cell for high pressure and high temperature structure studies on non-crystalline materials

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We have setup a Paris-Edinburgh Press (PEP) combined with a multi-channel collimator (MCC) assembly at the GSECARS beamline for monochromatic X-ray diffraction. The MCC has two arrays of fine slits arranged in two concentric circular arcs. Each array consists of 75 slits that are separated by 0.8°. The slit widths of the inner and outer arrays are 0.05 and 0.20 mm, respectively. The inner array is 50 mm away from the sample center while the outer one is 200 mm away. By oscillating the silts during data collection, background scattering from the surrounding cell parts can be effectively removed. The PEP is mounted on a general purpose diffractometer, with an area detector (MAR CCD) mounted on the two-theta arm. The incident Si(311) monochromatic beam (65keV) is focused horizontally with a large Kirkpatrick-Baez mirror to a beam size about 60 microns. With this setup, background scatter from the surrounding pressure media is completely removed at 2θ angles above 10° for samples larger than 0.5 mm in diameter. A 100-micron wide pin-hole clean-up collimator is used to remove tails of the focused incident beam. About 30 min. is sufficient to collect signals of a 2 mm diameter borosilicate glass sample (a weak scatterer), with minimal background scatter. The system is modularized into a few permanent units, allowing fast installation in station 13-ID-C. In order to extract the "real" X-ray diffraction signal from amorphous samples, proper corrections are necessary. The critical ones to be considered in the data analysis processes include background from the surrounding high pressure cell assembly, multiple scattering inside the hutch, dark field of the MARCCD detector, and the "shadow" effect of the MCC. Procedures for establishing proper transfer function have been tested. To increase pressure and temperature range, we have developed a cupped-toroidal Drickamer (CTD) anvil. The anvil design, with a central depression, a toroidal groove and a small tapered angle, combines features of modified Drickamer anvil and the traditional PE anvil. Pressures up to 19 GPa can be generated. Cell assemblies with thermally insulating materials have been developed and temperatures up to 2000°C have been maintained steadily over hours. This new setup is ideal for studying glass and liquid properties of low Z materials using monochromatic radiation, to complement the white-beam PEP setup at 16-BM-B (HPCAT).